Nested-grid modeling of mercury over North America

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Total Mercury Wet Deposition, 2005
Mercury Deposition Network (MDN)

precipitation
reactive mercury
global background
local sources
GEOS-Chem nested grid Hg simulation

Nested GEOS-Chem Hg simulation
- Same emission, chemistry, deposition, transport as global model
- Global Hg simulation provides boundary and initial conditions

Global and nested model
- GEOS-Chem Hg simulation with Br oxidation (Holmes et al., 2010)
- Br fields from GEOS-Chem (Parrella et al., 2011)
- No in-cloud reduction
- GEIA global anthropogenic emissions (Pacyna et al., 2006) scaled to 2006 (Streets et al., 2009)
- Anthropogenic emissions over US updated to EPA’s NEI 2005
Precipitation (2005)

Anthropogenic emissions Hg (2005)

Annual mean Hg wet deposition (2005)
Mercury wet deposition

GEOS-Chem annual mean mercury wet deposition (2004-2007)

Circles = Observations from Mercury Wet Deposition Network (MDN). 61 sites.

- West-East gradient: increasing precipitation + local anthropogenic emissions in NE US
- Model overestimates Hg deposition over Ohio River Valley (+36%) and NE (+25%)
- Previous studies: Reduction of Hg$^{II}$ to Hg$^{0}$ in power plant plumes (Edgerton et al., 2006) leads to improved agreement in models vs. measurements (Vijayaraghavan et al., 2008; Seigneur et al., 2003)
Mercury wet deposition

GEOS-Chem annual mean mercury wet deposition (2004-2007)

- Change power plant Hg partitioning: 57%, 40%, 3% (Hg^0/Hg^{II}/Hg^P) → 77%, 20%, 3%
- 10% reduction in deposition over Ohio River valley, 5% in other regions.

Circles = Observations from Mercury Wet Deposition Network (MDN). 61 sites.
Wet deposition along Gulf Coast

GEOS-Chem annual mean mercury wet deposition (2004-2007)

- Gulf Coast: good agreement on a monthly basis, a bit low
- Florida: model still underestimates wet deposition

MDN obs model
Global and regional source contribution

GEOS-Chem mercury wet deposition (2004-2007)

N. American contribution

- Sensitivity study with N. American anthropogenic emissions turned off
- N. American contribution to wet deposition: 36% over Ohio River Valley, 24% over SE, 6% over West Coast

Global contribution

Annual wet deposition by region

- US: 72% of wet deposition
- US: 28% of wet deposition
- OH: 36%
- West: 6%

Wet deposition (µg m⁻² year⁻¹)

- Wet deposition, MDN observations
- Wet deposition, US contribution
- Wet deposition, Global contribution

MW | NE | OH | SE | USA
---|----|----|----|----
28%| 24%| 36%| 20%| 28%
Recent decrease in US power plant Hg

GEOS-Chem mercury wet deposition (2008-2009)

40% reduction in power plant emissions

40% reduction in power plant emissions over Ohio River Valley!

Model wet dep decreases by 25% over Ohio River Valley!

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Wet deposition along Gulf Coast

GEOS-Chem annual mean mercury wet deposition (2004-2007)

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MDN obs model